100 Days of ML
Day38-Missing Indi...
Day39 - KNN Impu...
Day40 - Iterative I...
Day 41 - Outliers in...
Day 42 - Outlier De...
Day 43 - Outlier de...
Day44 - Outlier De...
Day 45 - Feature C...
Day 46 - Curse of...
Day 47 - PCA
Day 48 - Simple Li...
Day 49 - Regressio...
Day 50 - Multiple L...
Day 51 - Gradient...
Day 52 - Types of...
Day 53 - Polynomi...
Day 54 - Bias Varia...
Day 55 - Ridge Reg...
Day 56 - Lasso Reg...

Lasso Regression

Lasso Regression

Thursday, June 10, 2021 6:42 AM

L1 Regularization | overfitting → L2 reg

$$L = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 + \boxed{\lambda \|w\|^2}$$

↳ $\lambda(w_1^2 + w_2^2 + \dots + w_n^2)$

→ 0 $w_1 \to w_n \to$ coeff

↳ Lasso

L1 norm $\lambda \left[|w_1| + |w_2| + |w_3| + \dots + |w_n| \right]$

→ $L = MSE + \boxed{\lambda \|w\|}$ $|\,|$

→ code implement (sklearn)

→ Key point →

→ Difference Ridge Vs Lasso

Lasso Regression | Intuition and Code Sample | Regularized Linear Models

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Lasso Regression

alpha

↳ Lasso

L1 norm → $[\,|w_1| + |w_2| + \dots$

$$L = MSE + \boxed{\lambda \|w\|}$$

underfitting

$\lambda = 0 \rightarrow$ Linear

→ code implement (sklearn)

→ Key point →

→ Difference Ridge Vs Lasso

overfitting

degree

0.5

0.2

$x_1 \quad x_2 \quad x_3 \quad 0 \quad 0 \quad x_n \quad y$

ridge

lasso → λ → ↑

dim <

feature selection

0

decrease

lasso

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dim < decrease

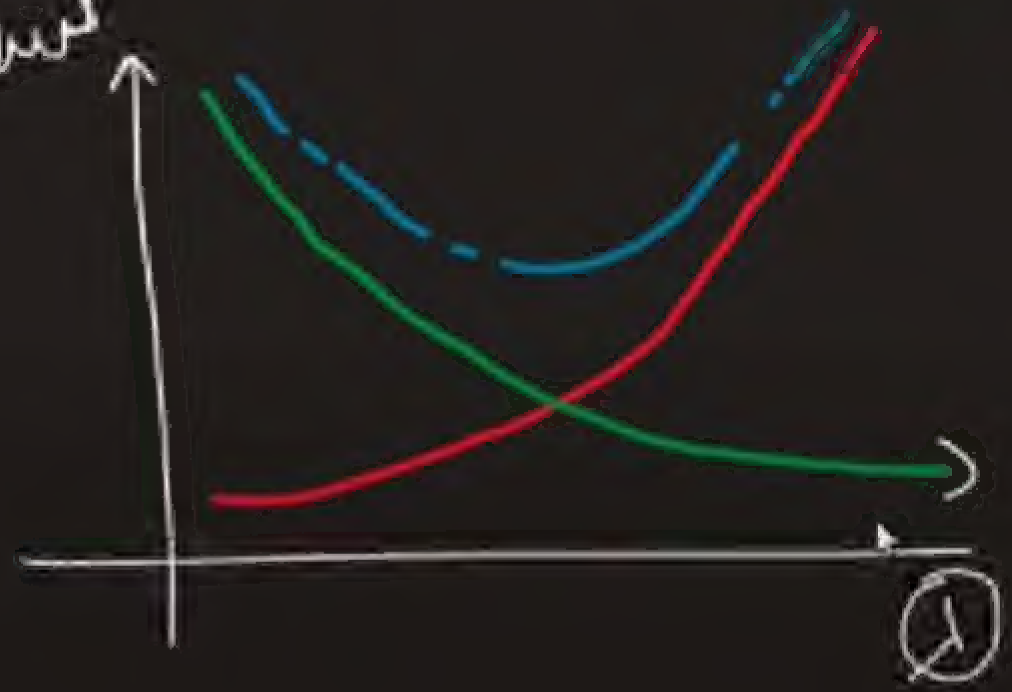
$\lambda \uparrow$

overfitting $\downarrow$ Bias $\uparrow$

Variance $\downarrow$

Variance $\uparrow$ Bias $\downarrow$

value



Red → bias
green – variance
blue – total error

0.0001	-9.071288	-205.337332	516.780313	340.539730	-888.652320	555.952271	150.585260	125.453044	858.639860	52.379002
0.0010	-8.264924	-204.213177	517.641106	339.751339	-826.653342	508.609613	120.899583	113.924518	836.314382	52.011583
0.0100	-1.361404	-192.944226	526.348511	332.649058	-430.205495	191.277876	-44.048113	68.990747	688.384976	47.939528
0.1000	0.000000	-113.976046	526.737112	292.635423	-82.691928	-0.000000	-152.691332	0.000000	551.077200	7.169852
1.0000	0.000000	0.000000	363.882636	27.278420	0.000000	0.000000	-0.000000	0.000000	336.135971	0.000000
10.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-0.000000	0.000000	0.000000	0.000000
100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-0.000000	0.000000	0.000000	0.000000
1000.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-0.000000	0.000000	0.000000	0.000000
10000.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-0.000000	0.000000	0.000000	0.000000

simple

x | y $\rightarrow$ $y = mx + b$

$b = \bar{y} - m\bar{x}$

$\bar{y} \rightarrow mean(y)$

$\bar{x} \rightarrow mean(x)$

$$m = \frac{\sum_{i=1}^{n} (y_i - \bar{y})(x_i - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

$$m = \frac{\sum_{i=1}^{n} (y_i - \bar{y})(x_i - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2 + \lambda}$$

x | y

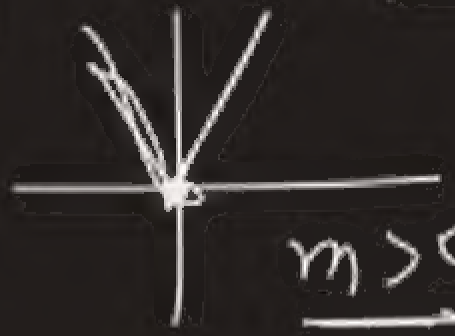
$i=1$

$b = \bar{y} - m\bar{x}$

$\bar{y} \to mean(y)$

$\bar{x} \to mean(x)$

$$m = \frac{\sum_{i=1}^{n} (y_i - \bar{y})(x_i - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$



$m > 0$

$|m| = m$

λm

$\boxed{b = \bar{y} - m\bar{x}}$ $\quad m = ?$

$$L = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 + \lambda |m|$$

$$\frac{d}{dm} \sum_{i=1}^{n} (y_i - m x_i - \bar{y} + m\bar{x})^2 + 2\lambda m$$

$$\frac{dL}{dm} = \sum_{i=1}^{n} (y_i - m x_i - \bar{y} + m\bar{x})^2 + 2\lambda |m| = 2 \sum (y_i - m x_i - \bar{y} + m\bar{x})(-x_i + \bar{x}) + 2\lambda = 0$$

$$L = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 + \lambda |m|$$

$$\frac{d}{dm} \sum_{i=1}^{n} (y_i - m x_i - \bar{y} + m\bar{x})^2 + 2\lambda m$$

$$\frac{dL}{dm} = \sum_{i=1}^{n} (y_i - m x_i - \bar{y} + m\bar{x})^2 + 2\lambda |m| = 2 \sum (y_i - m x_i - \bar{y} + m\bar{x})(-x_i + \bar{x}) + 2\lambda = 0$$

$$-2 \sum \left[(y_i - \bar{y}) - m(x_i - \bar{x}) \right] (x_i - \bar{x}) + 2\lambda = 0$$

$$-\sum \left[(y_i - \bar{y})(x_i - \bar{x}) - m(x_i - \bar{x})^2 \right] + \lambda = 0$$

$$-\sum (y_i - \bar{y})(x_i - \bar{x}) + m \sum (x_i - \bar{x})^2 + \lambda = 0$$

$$m \sum (x_i - \bar{x})^2 = \sum (y_i - \bar{y})(x_i - \bar{x}) - \lambda$$

$$\boxed{m = \frac{\sum (y_i - \bar{y})(x_i - \bar{x}) - \lambda}{\sum (x_i - \bar{x})^2}}$$

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Lasso   coeff   sparsity

for $m > 0$

$$m = \frac{\sum (y_i - \bar{y})(x_i - \bar{x}) - \lambda}{\sum (x_i - \bar{x})^2}$$

for $m = 0$

$$m = \frac{\sum (y_i - \bar{y})(x_i - \bar{x})}{\sum (x_i - \bar{x})^2}$$

for $m < 0$

$$m = \frac{\sum (y_i - \bar{y})(x_i - \bar{x}) + \lambda}{\sum (x_i - \bar{x})^2}$$

Why Lasso Regression creates sparsity?

Lasso

$\boxed{\text{for } m>0}$ $\qquad \lambda>0$

$$m = \frac{\boxed{\sum (y_i-\bar{y})(x_i-\bar{x})} - \lambda}{\sum (x_i-\bar{x})^2}$$

for $m=0$

$$m = \frac{\sum (y_i-\bar{y})(x_i-\bar{x})}{\sum (x_i-\bar{x})^2}$$

for $m<0$

$$m = \frac{\sum (y_i-\bar{y})(x_i-\bar{x}) + \lambda}{\sum (x_i-\bar{x})^2}$$

$m \rightarrow$

$2, \frac{9}{5}, 1, 0, -1, 5$ $\qquad 0$

$\lambda \uparrow$

$$m = \frac{YX - \lambda}{X^2} \qquad \left\{ \begin{array}{l} YX = 100 \\ X^2 = 50 \end{array} \right.$$

$\lambda = 100$

$\boxed{m = 0}$ $\qquad 150$

$$m = \frac{YX + \lambda}{X^2} = \frac{100+\lambda}{50}$$

$$m = \frac{100-\lambda}{50}$$

$\lambda = 0$, $m = 2$ | $\lambda = 10$, $m = \frac{9}{5}$

$\lambda = 50$ $m = 1$

$\lambda > 100$

$m = -1$ $\qquad 150$

$$= \frac{100+150}{50} =$$

$m = 5$

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$m = \frac{100 - \lambda}{50}$ $m = 2$ | $m = \frac{9}{5}$ $m = -1$ 150 $= \frac{100+\ldots}{50} =$

$\lambda = 50 \quad m = 1$

$m = 5$

λ −ve

$m < 0$ $m = \frac{\sum (y_i - \bar{y})(x_i - \bar{x}) + \lambda}{\sum (x_i - \bar{x})^2}$ $m = \frac{-100 - \lambda}{50}$

$\lambda > 0$

$= \frac{-100 - 150}{50} = -5$

$m = \frac{-100 + \lambda}{50}$ $\lambda = 0 \quad m = -2$

$\lambda = 50 \quad m = -1$ $\lambda = 150, \; m = -5$

$\boxed{m = 1}$ $\lambda = 100 \quad m = 0 \rightarrow 1$ 1) $0 \rightarrow$

$\lambda = 150$ 2) stop

Why Lasso Regression creates sparsity?

$$m = \frac{-100 + \lambda}{50}$$

$\lambda = 0 \quad m = -2$

$\lambda = 50 \quad m = -1$

$\lambda = 100 \quad m = 0 \rightarrow 1$

$\lambda = 150$

$\lambda = 150, \; m = -5$

$\boxed{m = 1}$

1) $0 \rightarrow$

2) stop

$$m = \frac{\overset{0.1}{\sum} (y_i - \bar{y})(x_i - \bar{x}) \rightarrow 0 \times}{\sum (x_i - \bar{x})^2 + \lambda}$$

0

$\lambda \rightarrow$

Ridge $<< 0$

$== 0$

Lasso $\rightarrow \lambda \rightarrow$ numerator

$\lambda = 10000000$

Denominator